Global Precipitation Measurement Mission

Microphysical Measurements during OLYMPEX

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Objectives

- Characterize vertical profiles of cloud microphysical properties near the western Washington coast as a function of geographic location.
- Examine how in-situ measured cloud properties and remote sensed radar properties vary along a sampling transect of stratiform precipitation observed on 1-2 December 2015.

Methods

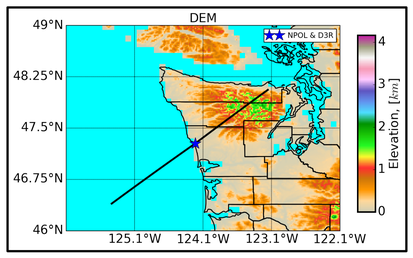

Fig. 1: Digital elevation map of NW Washington State. NPOL radar location indicated by the blue star. Black line indicates flight transect of DC-8 on 1-2 December 2015

- During November and December 2015, 20 IOP flight days were conducted during the OLYMPEX field campaign.
- Composite size distributions and bulk microphysical properties [median mass diameter (Dmm), ice water content (IWC) and number of particles with size greater than 125 microns ($N_{>125}$)] were computed from a combination of a vertically oriented two-dimensional stereo (2D-S) probe and a vertically oriented high volume precipitation spectrometer (HVPS-3) aboard the UND Citation.
- Dmm and IWC used Heymsfield et al. (2004) m-D relation.
- Data were categorized spatially. Any data collected west of the NPOL radar location (Fig. 1) were designated **ocean**, and any data collected east of NPOL were designated **land**.
- Vertical remote sensing was collected from the Airborne Precipitation Radar Third Generation (APR3) aboard the NASA DC-8.
- Citation sampling strategy consisted of constant altitude flight legs and spiral descents/ascents. DC-8 made repeated overpasses.

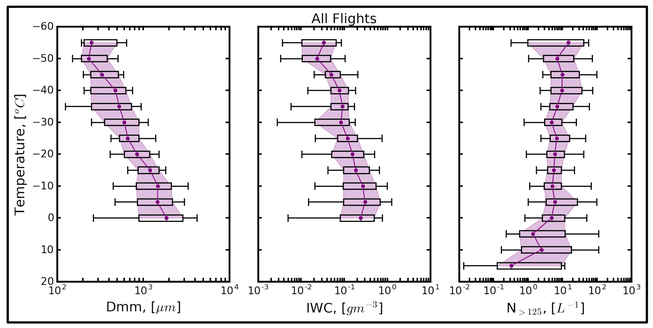

Fig. 2: Bulk Microphysical properties binned vertically by 5℃ bins and plotted on the right bin edge (e.g. 0 – 5 ℃ bin is plotted at 5 ℃) . Boxplot lines from left to right are as follows: 10th, 25th, 50th,75th, and 90th percentile. The interquartile range is shaded.

Profiles: Land vs Ocean

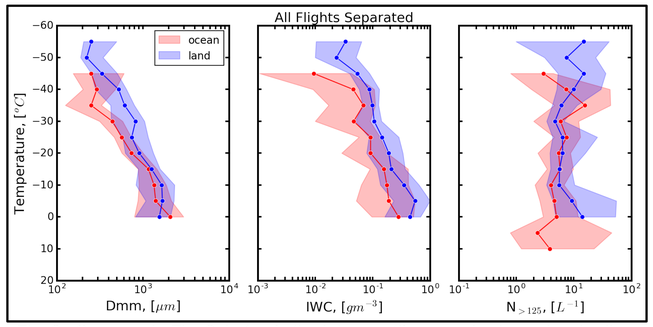

Fig. 3: Same as in Fig. 2, but only the interquartile range is shown by shading. Blue is **land**, red is **ocean**

- Dmm and IWC are consistently greater over **land** than **ocean**. This is .hypothesized to be a result of additional vertical forcing.
- A Mann-Whitney test showed that for most temperatures, Dmm and IWC are greater over land in a statistically significant manner.

Case Study

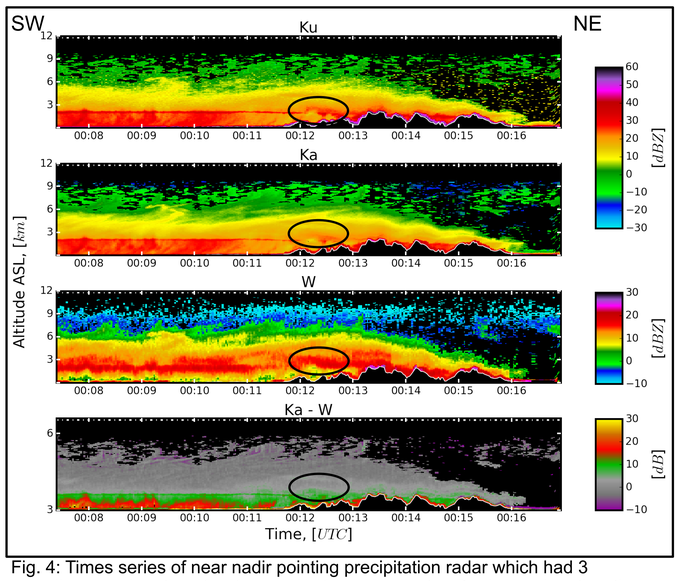

Fig. 4: Times series of near nadir pointing precipitation radar which had 3 sampling wavelengths; Ku, Ka and W. Ka – W indicates Dual-Wavelength ratio between Ka and W.

- 1-2 December 2015: A region of large stratiform precipitation, the result of a mid-latitude cyclone, propagated across the OLYMPEX domain.
- Accumulated precipitation along the sampling transect ranged from 20 to 50 mm.
- The DC-8 APR3 shows the melting layer at ~2 km and potentially some orographic influence around 00:12 UTC 2 December 2015 (circled region).

Case Study Cont.

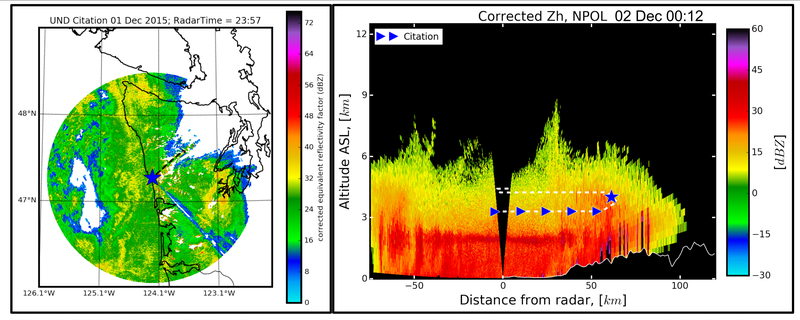

Fig. 5: PPI (left) and RHI (right) scans from NASA NPOL indicated by blue star on left. Dashed white line with blue triangles (right) is the track of the UND Citation and the blue star on the right is a particular time/area of interest.

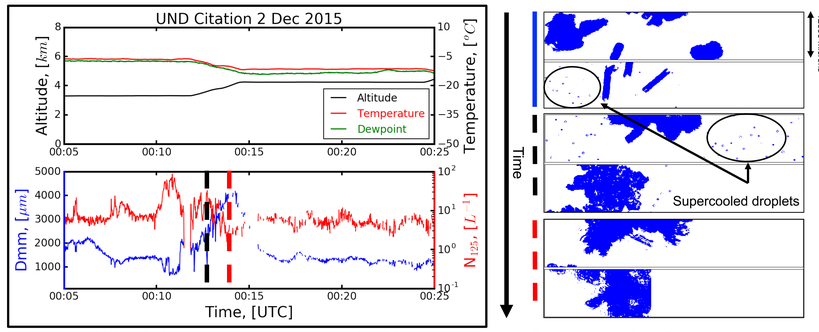

Fig. 6: (Left) UND Citation time series data for 00:05 - 00:25 on 2 December 2015 flying along the track shown in Fig 5. (Right) 2D-S images at 00:05, 00:13 and 00:14 in descending order.

- As the Citation flies towards the topography, Dmm increases.
- 2D-S particle images show increased supercooled liquid water located closer to topography, hypothesized to be from increased vertical motion.
- The higher supercooled water content leads to larger ice crystals attributed to the riming process.

Conclusions

- **Land** – **ocean** separation of in-situ microphysical data from OLYMPEX show statistically significant differences in Dmm, IWC and $N_{>125}$.
- A case study on 1-2 December 2015 suggests that orographic lifting and additional riming growth of hydrometeors could be causing the differences in the profiles.
- Future work will further distinguish how microphysical properties and size distribution parameters vary with geographic location and meteorological regime.

Acknowledgments

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